

**Data Control Points Used to Construct
the Surficial Geology Map
of Lincoln County, Kansas
(M-127)**

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**KGS OPEN-FILE
REPORT 2023-52**

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Introduction

This report is a supplemental reference to the Surficial Geology of Lincoln County, Kansas, map (M-127) (Sawin, 2023) and is a synthesis of the field data used to construct the map.

Field work for the geologic map involved systematically locating exposures in quarries and along streams and roadways. Localities where the contact between mappable units can be recognized, along with other attributes that are pertinent to the investigation, were recorded electronically on a tablet PC with built-in GPS (global positioning system). In addition, the outcrop and other related details are digitally photographed, and if warranted, the section is measured and described. These localities are referred to as **data control points** because they function as “ground truth” for the mapping that is refined and completed in the lab. Field data, photographs, and measured sections are also incorporated into the geologic interpretation.

Paper copies of the U.S. Geological Survey topographic quadrangles (scale of 1:24,000) were also used in the field for navigation, geologic sketching, and notes. The data control points were plotted manually on the quadrangles to provide backup for the electronic record.

The stratigraphic names used herein are from Zeller ([1968] 2022).

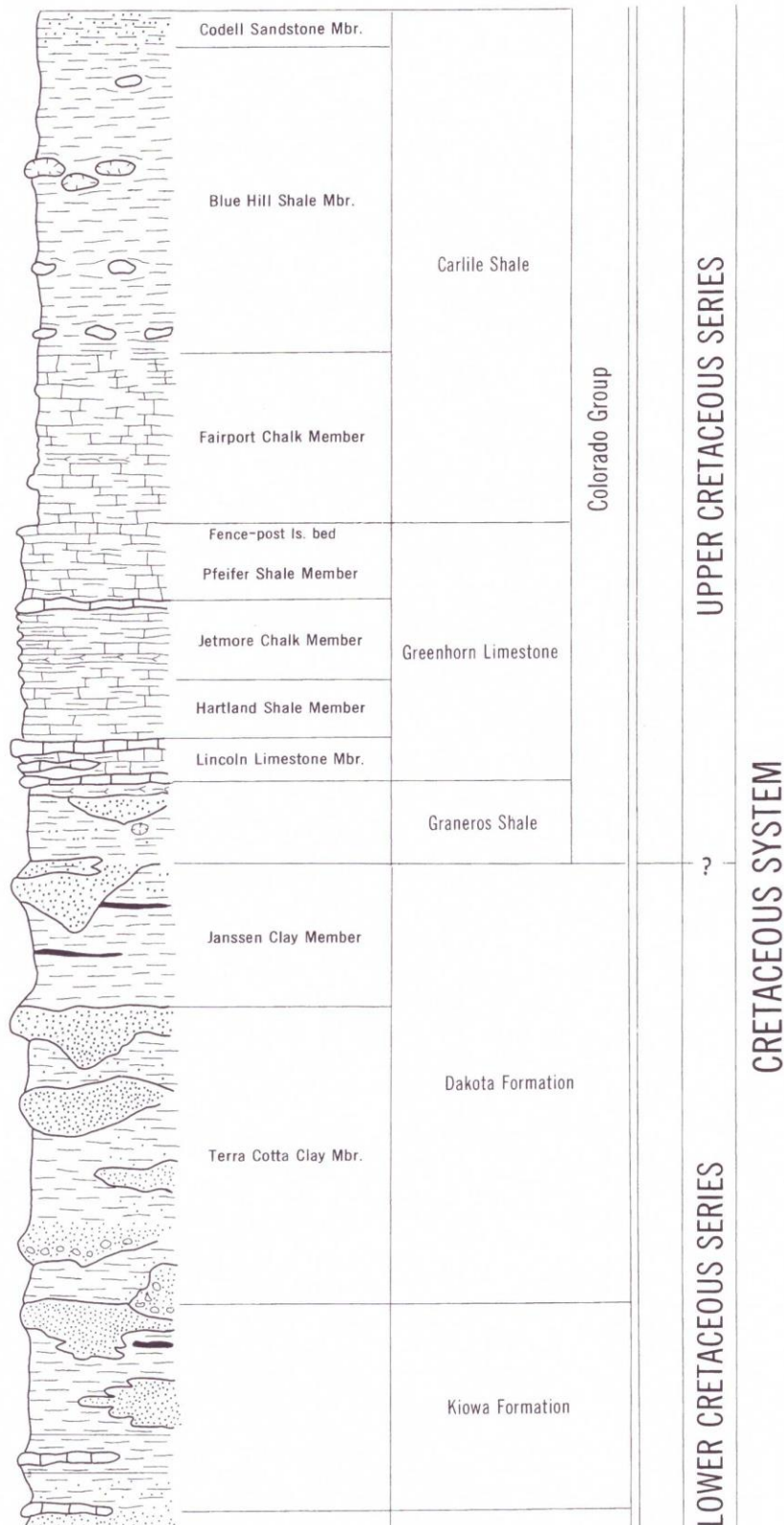
Numbering System and Organization. Data control points used in mapping the bedrock geology are organized by quadrangle in this report. Although recorded sequentially when the field work was conducted, they were subsequently reorganized by quadrangle for mapping purposes.

The “LC” prefix stands for Lincoln County. Control points taken from Kansas Department of Transportation plans and profiles are designated with the “KDOT” prefix.

Refer to the Table of Contents and Index Map (p. 8) to locate quadrangles of interest within Lincoln County. The locations of specific control points are listed by GPS coordinates (p. 9) and described legally within the descriptions.

Photograph Scale. The orange and white markings on the staff used for scale in the photographs are in one-foot increments.

Generalized Stratigraphic Column



(from Zeller, [1968] 2022)

Lithologic Descriptions

These descriptions are a compilation of several sources, including field notes and measured sections, Kansas Department of Transportation geological reports and profiles, and lithologic descriptions in Berry (1952), Bayne et al. (1971), and Arbogast and Johnson (1996).

Alluvium and Terrace Valley Fill—Alluvium and terrace valley fill are found along the Saline River and its tributaries. Floodplain deposits contain mostly silt and clay with some sand. The thickness of the alluvium ranges up to 60 ft (18 m) in the Saline River valley and 20 ft (6 m) in other major tributaries in the county (Berry, 1952).

Pre-Illinoian fluvial valley fill and eolian silt—Pleistocene deposits in Lincoln County contain clay, silt, sand, gravel, eolian silt, and volcanic ash. Composed of a basal sand and gravel overlain by an eolian silt, and with a total thickness of up to 40 ft (12 m) (Berry, 1952), the deposit unconformably overlies Dakota, Graneros, and Greenhorn strata in the southwest corner of the county. This occurrence represents the channel fill remnants of the ancestral Saline River, named the "Wilson valley," that flowed southeasterly to the Smoky Hill River in Ellsworth County during pre-Illinoian time. The term "pre-Illinoian" replaces the classic Pleistocene glaciation terms Nebraskan, Aftonian, Kansan, and Yarmouthian in Kansas (Layzell et al., 2017). Berry (1952) placed a Pearlette family ash bed in the upper eolian silt in Lincoln County, reporting the ash to be 3–12 ft (1–4 m) thick. It has been identified as the Lava Creek B ash bed (Pearlette family ash beds), whose source is from the last major eruption of the Yellowstone Caldera 620,000 years ago (Carey et al., 1952; Izett and Wilcox, 1982).

Carlile Shale—The Carlile Shale contains three members. In ascending order, they are the Fairport Chalk Member, the Blue Hill Shale Member, and the Codell Sandstone Member. Only the lower part of the Fairport Chalk Member is present in Lincoln County, where it is up to 20 ft (6 m) thick and very similar to the upper beds of the Greenhorn Limestone (Berry, 1952). It consists of alternating beds of thin, concretionary limestone and chalky mudrocks, as well as thin bentonite layers. The Carlile Shale caps the high hills in the northern and southwestern parts of the county.

Greenhorn Limestone—The Greenhorn Limestone contains the following four members, in ascending order: the Lincoln Limestone Member, the Hartland Shale Member, the Jetmore Chalk Member, and the Pfeifer Shale Member. Each member is 15 to 20 ft (5 to 6 m) thick. The contacts between the members are gradational and not easily recognized in the field. In general, the Greenhorn is light gray to yellowish-gray chalky limestone, chalky mudrock, and chalk. Several limestone beds contain the fossil clam *Inoceramus* sp. that is characteristic of the formation. The lower part of the Greenhorn (Lincoln Member) is interbedded layers of chalky mudrock, chalky limestones, and dark gray crystalline limestone near the base that has a strong petroliferous odor when freshly broken. The middle part (Hartland and Jetmore Members) is chalky mudrock with interbedded layers of nodular limestone, chalky limestone, and bentonite. The upper part of the formation (Pfeifer Member) is interbedded thin chalky limestones and chalky mudrocks containing bentonite seams and is capped by the *Fence-post limestone bed*, a 0.7 ft (0.2 m) thick limestone that weathers light tan with a rust-colored line in the middle. The Fence-post bed has been quarried extensively in Lincoln County. The Greenhorn is 65 to 90 ft (20 to 27 m) thick in Lincoln

County (Berry, 1952) and forms the prominent escarpments of the upland areas in the northern, southwest, and south-central parts of the county.

Graneros Shale—The Graneros Shale is a gray to dark gray, noncalcareous, fissile shale that weathers to light gray and yellow-brown. Small flakes of the light gray fissile shale are characteristic of the weathered outcrop. Interbedded layers of fossiliferous (predominately *Inoceramus* sp. and *Ostrea* sp.) sandstone and limestone (up to 2 ft [0.6 m] thick) occur in the middle to lower part of the formation in Lincoln County, and thin (0.3 ft [0.1 m]) beds of limestone often occur near the top. A 1 ft (0.3 m) bentonite bed may be present near the top. Disseminated gypsum and selenite crystals also occur in the Graneros. In Lincoln County, the thickness of the Graneros Shale ranges from 20 to 45 ft (6 to 14 m). The Graneros Shale forms low hills above the Dakota Formation adjacent to the valleys and gentle slopes between the Dakota and the Greenhorn Limestone in the uplands. Landslides characterize the Graneros horizon.

Dakota Formation—The Dakota Formation is composed of two members: the lower Terra Cotta Clay Member and the upper Janssen Clay Member. The Dakota is composed of varicolored clay, claystone, and shale with irregular and sometimes massive lenses of siltstone and sandstone. The mudrocks are red-mottled pale-gray, tan to brown clay and silt. The interbedded sandstone lenses are fine to medium grained, very light gray to orange-tan to dark red-brown, and commonly poorly cemented. Concretions and thick layers of hard, gray, calcite-cemented sandstone (locally referred to as “Lincoln quartzite”) are found in Lincoln County in small, isolated areas, but extensive deposits near Lincoln, Kansas, are mined for aggregate. The Dakota often contains lignite and carbonaceous fragments, and small concretions and thin beds of limonite, siderite, and hematite occur as scattered fragments on eroded mudrock surfaces. The Dakota Formation ranges from about 140 ft (43 m) thick in eastern Lincoln County to about 200 ft (61 m) in the western part (Berry, 1952) and is an important source of water in Lincoln County and elsewhere in Kansas. The Dakota is exposed in much of the central and southeastern parts of the county in areas adjacent to the Saline River and its tributaries.

Kiowa Formation—The upper part of the Kiowa Formation is present at the surface only in the extreme southeast corner of Lincoln County, where gray to dark gray shale and siltstone and fine-grained orange-tan sandstones crop out near the boundaries with Ellsworth and Saline counties.

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Index Map – Lincoln County 7.5 Minute Quadrangles

LINCOLN COUNTY, KANSAS

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| 2 Ash Grove-1968 | 12 Wilson NE-1964 |
| 3 Lincoln NW-1968 (80 PR) | 13 Westfall NW-1964 |
| 4 Barnard-1964 | 14 Westfall-1963 |
| 5 Ada-1964 | 15 Juniata-1963 (79 PR) |
| 6 Sylvan Grove-1963 | 16 Wilson-1956 (79 PR) |
| 7 Vesper-1962 | 17 Black Wolf-1957 (79 PR) |
| 8 Lincoln-1962 | 18 Westfall SW-1957 (79 PR) |
| 9 Shady Bend-1963 | 19 Westfall SE-1957 (79 PR) |
| 10 Tescott-1965 | 20 Brookville SW-1957 (79 PR) |

PR Photorevised

GPS Coordinates

Control Point Number	Latitude	Longitude
LC01	38.8710785	-97.9282303
LC02	38.8751945	-97.9464798
LC03	38.8708153	-97.9733810
LC04	38.8703308	-97.9298248
LC05	38.8926430	-97.9658051
LC06	38.9117355	-97.9636688
LC07	38.9757042	-97.9366760
LC08	38.9765511	-97.9285965
LC09	38.9925079	-97.9355621
LC10	38.9367828	-97.9841232
LC11	38.9399719	-98.0928650
LC12	38.9283447	-98.1239014
LC13	38.9868736	-98.1855087
LC14	38.9868774	-98.1821823
LC15	38.9856758	-98.1786880
LC16	38.9449005	-98.1731567
LC17	38.9432030	-98.1767273
LC18	38.9431458	-98.1772919
LC19	38.9431915	-98.1802673
LC20	38.9433174	-98.1848831
LC21	38.8993454	-98.2438126
LC22	38.9285889	-98.1877975
LC23	38.9287720	-98.1998749
LC24	38.9286880	-98.1818008
LC25	38.8778915	-98.1798401
LC26	39.0012627	-98.1580429
LC27	39.0015984	-98.1640778
LC28	39.0117645	-98.1655960
LC29	39.0186539	-98.1517105
LC30	39.0307732	-98.1501312
LC31	39.0345154	-98.1474609
LC32	39.0761108	-98.1510239
LC33	39.0522423	-98.2015991
KDOT1	38.8705902	-98.0628586
KDOT2	38.8746185	-98.0437927
KDOT3	38.8745613	-98.0416031
LC34	38.8855896	-98.2321396
LC35	38.8860779	-98.2277069
LC36	38.9001999	-98.2066574
LC37	39.0593567	-98.1227264
LC38	39.0594101	-98.1201401

LC39	39.1034622	-98.2232742
LC40	39.0911217	-98.2069092
LC41	39.0160103	-98.3557816
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LC43	39.0386429	-98.3204269
LC44	39.0678940	-98.3173828
LC45	39.0468483	-98.3551483
LC46	39.0896873	-98.3543472
LC47	39.0532646	-98.4233017
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LC50	39.0837860	-98.4843979
LC51	39.0741425	-98.4304504
LC52	39.0725250	-98.4286499
LC53	39.0989494	-98.4301376
LC54	39.0449944	-98.4501038
LC55	39.0477905	-98.4294739
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LC57	39.0307198	-98.4663239
KDOT4	39.0306129	-98.3975067
LC58	38.9196815	-98.2436829
LC59	38.9582367	-98.4676590
LC60	38.8919754	-98.4303284
LC61	38.8690262	-98.4680557
LC62	38.8685188	-98.4685516
LC63	38.8664017	-98.4692078
LC64	38.9339714	-98.4532242
LC65	38.9625473	-98.4854050
LC66	38.9081802	-98.4095993
LC67	38.9147606	-98.4246140
LC68	38.9289360	-98.3893127
LC69	38.8906288	-98.3001480
LC70	38.9050293	-98.2813492
LC71	39.1616707	-98.4607925
LC72	39.1708565	-98.4150925
LC73	39.1763954	-98.4525681
LC74	39.1906738	-98.4424438
LC75	39.1466789	-98.3798904
LC76	39.1479301	-98.2845993
LC77	39.1813622	-98.2469864
LC78	39.2122345	-98.2099838
LC79	39.1950912	-98.2100143
LC80	39.1802444	-98.1347427
LC81	39.1913376	-98.1347885
LC82	39.1758957	-98.1412048
LC83	39.2145386	-98.0933685
KDOT5	38.8735619	-98.4735870

KDOT6	38.8836784	-98.4726791
KDOT7	38.8850975	-98.4725113
KDOT8	38.9213181	-98.4763031
KDOT9	38.9221649	-98.4764023
KDOT10	38.9277382	-98.4767838
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LC86	39.1080894	-98.1194611
LC87	39.1080818	-98.1230927
LC88	39.1103745	-98.1041794
LC89	39.1105499	-98.0787201
LC90	39.1358986	-98.0463181
LC91	39.2145882	-97.9487686
LC92	39.1153450	-98.0027695
LC93	39.1113625	-98.0027542
LC94	39.1035042	-98.0037537
LC95	39.0889626	-98.0182343
LC96	39.0600624	-98.0130081
LC97	39.0600319	-98.0056686
LC98	39.1169930	-97.9358673
LC99	39.0599899	-98.0295334
LC100	39.0525398	-98.0465088

1 HUNTER QUADRANGLE—LINCOLN COUNTY

Field work conducted 07 Feb 2017; 08 Feb 2017

LC71 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,620 ft in south road ditch; several Fence-post quarries in area are misidentified on 7.5 minute quadrangles as gravel pits; NW NW NE sec. 29, T. 10 S., R. 10 W. Photo LC71-1.



LC72 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,620 ft in road; small Fence-post quarry just east of fence in pasture; NW SW NW sec. 23, T. 10 S., R. 10 W. Photo LC72-1.



LC73 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,615 ft at intersection of two dirt roads; Fence-post quarry in southeast corner of intersection; recent telephone cable installation ripped up several blocks of Fence-post limestone; NW NW NW sec. 21, T. 10 S., R. 10 W. Photos LC73-1, LC73-2.



LC74 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,575 ft in road and quarry south of road; NW NW NE sec. 16, T. 10 S., R. 10 W. Photo LC74-1.



LC75 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,565 ft in road; Fence-post quarries on both sides of road; NE NE NE sec. 36, T. 10 S., R. 10 W. Photo LC75-1.



2 ASH GROVE QUADRANGLE—LINCOLN COUNTY

Field work conducted 08 Feb 2017

LC76 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,530 ft in road; small Fence-post quarry approximately 100 ft southwest; SE SE SE sec. 26, T. 10 S., R. 9 W. Photo LC76-1.



3 LINCOLN NW QUADRANGLE—LINCOLN COUNTY

Field work conducted 08 Feb 2017; 09 Feb 2017

LC77 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,495 ft in road and east ditch; SW NW SW sec. 17, T. 10 S., R. 8 W. Photo LC77-1.



LC78 – Base of Greenhorn Limestone at 1,435 ft in road and roadcut, Graneros Shale poorly exposed below; basal limestone (Lincoln Limestone Member) has very petroliferous odor; SE SE NE sec. 4, T. 10 S., R. 8 W. Photo LC78-1.



LC79 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,510 ft in road ditch and pasture on west side of road; SE NE SE sec. 9, T. 10 S., R. 8 W. Photo LC79-1.



LC80 – Base of Greenhorn Limestone at 1,450 ft in gravel road; Lincoln limestone is thin (less than 2 ft), dark gray, crystalline, with strong petroliferous odor; contact not exposed and no Graneros Shale was observed below; Dakota Formation mudrock is exposed in the road approximately 400 ft south of this location at 1,435 ft — therefore, the Graneros Shale is only 15 ft thick; SE NE SE sec. 18, T. 10 S., R. 7 W. Photo LC80-1.



LC81 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,515 ft in dirt road and roadcut less than 0.1 mi north of K284; Fence-post quarry adjacent to west with several in this area; SE SE SE sec. 7, T. 10 S., R. 7 W. Photos LC81-1, LC81-2.



LC82 – Base of Greenhorn Limestone at 1,490 ft in road; Lincoln limestone is thin (less than 2 ft), dark gray, crystalline, with strong petroliferous odor; Graneros Shale observed below, contact apparent; Dakota Formation evident in road below (east) at 1,475 ft — therefore, Graneros Shale is approximately 15 ft thick; NE NW NE sec. 19, T. 10 S., R. 7 W. Photo LC82-1.



4 BARNARD QUADRANGLE—LINCOLN COUNTY

Field work conducted 09 Feb 2017; 20 Mar 2017; 21 Mar 2017

LC83 – Dakota Formation and limestone float (probably Greenhorn) in road at 1,395 ft; excellent exposure of Dakota below; NW SE NW sec. 3, T. 10 S., R. 7 W. Photos LC83-1, LC83-2, LC83-3.



LC84 – Base of Graneros Shale in road at 1,413 ft; contact is not sharp but change from sandstone to gray fissile shale is evident; NE NW NW sec. 23, T. 10 S., R. 7 W. Photo LC84-1.



LC85 – Base of Greenhorn Limestone in road at 1,440 ft; contact is not sharp but Lincoln limestone (dark gray, crystalline, petroliferous odor) is in road with dark gray, fissile shale below; approximately 200 ft east of LC84; NE NW NW sec. 23, T. 10 S., R. 7 W. Photo LC85-1.



LC90 – Base of Carlile Shale (top of Fence-post limestone bed) in road at 1,535 ft, Fence-post quarries on both sides of road; NW NW NW sec. 6, T. 10 S., R. 7 W. Photos LC90-1, LC90-2.



5 ADA QUADRANGLE—LINCOLN COUNTY

Field work conducted 21 Mar 2017

LC91 – Base of Greenhorn Limestone in road at 1,470 ft; very poor exposure but Lincoln limestone is dark gray, crystalline, with petroliferous odor; Graneros Shale below and yellow tan, no contact exposed; NW NW sec. 6, T. 13 S., R. 7 W. Photo LC91-1.



6 SYLVAN GROVE QUADRANGLE—LINCOLN COUNTY

Field work conducted 19 Feb 2016

LC47 – Fence-post limestone bed quarry north of Ramo Decker home; bottom of quarry (presumed base of Carlile Shale/top of Fence-post limestone bed) at 1,600 ft; SW SE NW sec. 34, T. 11 S., R. 10 W. Photos LC47-1, LC47-2.



LC48 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,670 ft in dirt road approximately 200 ft west of Lincoln/Russell County line; SW SE NW sec. 24, T. 11 S., R. 11 W. Photo LC48-1.



LC49 – Greenhorn Limestone in stream cutbank approximately 100 ft east of road; interbedded chalky limestone and chalky shale; elevation of exposure is approximately 1,620 ft; SW NW SW sec. 19, T. 11 S., R. 10 W. Photos LC49-1, LC49-2.



LC50 – Greenhorn Limestone in road ditch at 1,625 ft, no contact; NW SW NW sec. 19, T. 11 S., R. 10 W. Photo LC50-1.



LC51 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,600 ft in Vonada Stone Quarry; approximately 4 ft of Carlile exposed above Fence-post; SE SE SE sec. 21, T. 11 S., R. 10 W. Photos LC51-1, LC51-2, LC51-3, LC51-4.



LC52 – Greenhorn Limestone exposed in north-facing stream cutbank at elevation 1,565 ft (no contact) approximately 500 ft southeast of LC51; NW NW NW sec. 27, T. 11 S., R. 10 W. Photo LC52-1.



LC53 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,600 ft in small Fence-post quarry; NE SE NE sec. 16, T. 11 S., R. 10 W. Photo LC53-1.



LC54 – Greenhorn Limestone in roadcut at top of hill at elevation 1,535 ft (no contact); SE SE SE sec. 32, T. 11 S., R. 10 W. Photo LC54-1.



LC55 – Greenhorn Limestone in east road ditch at 1,590 ft (no contact); Fence-post quarry above and north; NW SW SW sec. 34, T. 11 S., R. 10 W. Photos LC55-1, LC55-2.



LC56 – Greenhorn Limestone in roadcut on west side of K181 at 1,610 ft (no contact); NW NW SE sec. 2, T. 12 S., R. 10 W. Photo LC56-1.



LC57 – Dakota Formation with calcite-cemented sandstone in pasture south and small area north of road; NW NW NW sec. 8, T. 12 S., R. 10 W. Photo LC57-1.



KDOT 4 – KDOT K18 plan and profile, base of Greenhorn Limestone at 1,582 ft; center north line NE sec. 11, T. 12 S., R. 10 W. No photo.

7 VESPER QUADRANGLE—LINCOLN COUNTY

Field work conducted 18 Feb 2016

LC41 – Quaternary gravel pit; NE NE NE sec. 18, T. 12 S., R. 9 W. Photo LC41-1.



LC42 – Greenhorn Limestone in K18 roadcut; no contacts exposed; SE SW SW sec. 6, T. 12 S., R. 9 W. Photos LC42-1, LC42-2.



LC43 – Dakota Formation in roadcuts on both sides of K18; SW SE NE sec. 4, T. 12 S., R. 9 W. Photos LC43-1, LC43-2, LC43-3 on north side of highway showing channel cut and fill.



LC44 – Greenhorn Limestone in road and ditch; no contacts observed; SW SW NW sec. 27, T. 11 S., R. 9 W. Photo LC44-1.



LC45 – Greenhorn Limestone at 1,595 ft in road and roadcuts; no contact observed; SE SE SE sec. 31, T. 11 S., R. 9 W. Photo LC45-1.



LC46 – Greenhorn Limestone at 1,580 ft on both sides of road; Graneros Shale exposed below but contact was not observed; SE SE SE sec. 18, T. 11 S., R. 9 W. Photo LC46-1.



8 LINCOLN QUADRANGLE—LINCOLN COUNTY

Field work conducted 28 Jan 2016; 17 Feb 2016

LC26 – Dakota Formation with calcite-cemented sandstone at 1,395 ft in road; extensive boulder field in pasture to north; SE SW SE sec. 13, T. 12 S., R. 8 W. Photo LC26-1.



LC27 – Dakota Formation with thick calcite-cemented sandstone at 1,400 ft on steep hillside north and south of road; SW SE SW sec. 13, T. 12 S., R. 8 W. Photos LC27-1, LC27-2, LC27-3.



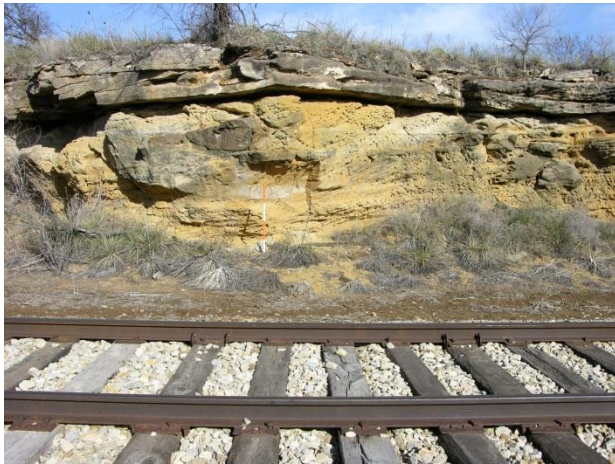
LC28 – Dakota Formation with calcite-cemented sandstone at 1,435 ft at road and boulder field west of road in pasture; active quarry east of road; near center NW sec. 13, T. 12 S., R. 8 W. Photo LC28-1.



LC29 – Dakota Formation with calcite-cemented sandstone at 1,405 ft in K14 roadcut; SE SE sec. 12, T. 12 S., R. 8 W. Photo LC29-1.



LC30 – Dakota Formation with calcite-cemented sandstone at 1,400 ft in K14 roadcut with soft sandstone below and in railroad cut just southwest of roadcut; SW SW SW sec. 6, T. 12 S., R. 7 W. Photos LC30-1, LC30-2, LC30-3.



LC31 – Dakota Formation sandstone (soft) in railroad cuts on both sides of Fourth Street in Lincoln; SW NE SW sec. 6, T. 12 S., R. 7 W. Photo LC31-1.



LC32 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,595 ft in K14 roadcut, east side of highway; Fence-post limestone bed exposed with Carlile Shale or residuum above; NW SW SW sec. 19, T. 11 S., R. 7 W. Photos LC32-1, LC32-2.



LC33 – Dakota Formation in K18 roadcut on both sides of highway; soft sandstone and mudrock except for one large calcite-cemented sandstone boulder at southwest corner of exposure; about 1,000 ft west of center sec. 34, T. 11 S., R. 8 W. Photos LC33-1, LC33-2.



LC39 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,580 ft in road and both ditches; NW NW NW sec. 16, T. 11 S., R. 8 W. Photos LC39-1, LC39-2.



LC40 – Base of Greenhorn Limestone at 1,540 ft in road and ditches with Graneros Shale exposed in ditches below; 2 ft calcareous sandstone in Graneros at 1,515 ft but it is reddish here instead of gray as in the southwest part of Lincoln County; SE SE SE sec. 16, T. 11 S., R. 8 W. Photos LC40-1, LC40-2.



9 SHADY BEND QUADRANGLE—LINCOLN COUNTY

Field work conducted 17 Feb 2016; 20 Mar 2017; 21 Mar 2017; 22 Mar 2017

LC37 – Dakota Formation (rubbly, reddish sandstone) in road and ditches at 1,490 ft; no contacts observed; SW SW SE sec. 29, T. 11 S., R. 7 W. Photo LC37-1.



LC38 – Base of Greenhorn Limestone at 1,550 ft in dirt road; Graneros Shale exposed below; SE SW SE sec. 29, T. 11 S., R. 7 W. Photo LC38-1.



LC86 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,590 ft in road and roadcuts; several feet of Carlile above with thin and nodular beds of chalky limestone; SE NW SE sec. 8, T. 11 S., R. 7 W. Photos LC86-1, LC86-2, LC86-3, LC86-4.



LC87 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,625 ft in road; top of Fence-post variable in this area (1,590 ft at LC86 and 1,585 ft in road and Fence-post quarry approximately 1,500 ft south); SW NW SE sec. 8, T. 11 S., R. 7 W. Photo LC87-1.



LC88 – Base of Greenhorn Limestone at 1,500 ft in roadcut on north side of road; dark gray, crystalline limestone with petroliferous odor (Lincoln Limestone Member); Graneros Shale not exposed; SW SW NE sec. 9, T. 11 S., R. 7 W. Photo LC88-1.



LC89 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,565 ft in abandoned Fence-post quarry; SE SE NE sec. 10, T. 11 S., R. 7 W. Photo LC89-1.



LC92 – Base of Greenhorn Limestone at 1,500 ft in road; Dakota, Graneros, and Greenhorn apparent in road but poorly exposed; SE NE NE sec. 8, T. 11 S., R. 6 W. Photos LC92-1, LC92-2.



LC93 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,540 ft in road; SE SE NE sec. 8, T. 11 S., R. 6 W. Photo LC93-1.



LC94 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,560 ft in road; Carlile exposed above Fence-post in road; SW SE SE sec. 8, T. 11 S., R. 6 W. Photo LC94-1.



LC95 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,565 ft in road ditch below Fence-post quarry north of road; SE SW SW sec. 18, T. 11 S., R. 6 W. Photos LC95-1, LC95-2.



LC96 – Base of Greenhorn Limestone at 1,510 ft in road; poor exposure (no contact observed) but Lincoln limestone is characteristic (dark gray limestone, crystalline, petroliferous odor); Graneros Shale very poorly exposed below; NE NE NW sec. 32, T. 11 S., R. 6 W. Photo LC96-1.



LC97 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,565 ft in road and roadcuts; Fence-post quarries on both sides of road; NW NE NE sec. 32, T. 11 S., R. 6 W. Photos LC97-1, LC97-2.



LC99 – Base of Greenhorn Limestone at 1,485 ft in south road ditch; contact sharp; NW NW NE sec. 31, T. 11 S., R. 6 W. Photo LC99-1.



LC100 – Base of Greenhorn Limestone at 1,515 ft in north road ditch; contact sharp; SE SW NE sec. 36, T. 11 S., R. 7 W. Photo LC100-1.



10 TESCOTT QUADRANGLE—LINCOLN COUNTY

Field work conducted 21 Mar 2017

LC98 – Dakota Formation with calcite-cemented sandstone at 1,360 ft in roadcut on south side of road and in hillside behind cut; exposure approximately 300 ft east appears to be a small quarry; NW NW NW sec. 6, T. 13 S., R. 7 W. Photos LC98-1, LC98-2.



11 WILSON NW QUADRANGLE—LINCOLN COUNTY

Field work conducted 16 Nov 2016; 05 Feb 2017; 06 Feb 2017

LC59 – Greenhorn Limestone in deep, south-facing roadcut, K118; no contacts; SE SE SE sec. 31, T. 12 S., R. 10 W. Photo LC59-1.



LC60 – Volcanic ash in east road ditch, small abandoned ash pit on west side of road; good exposure of pre-Illinoian deposits along road north and south of LC60; NW NW SW sec. 27, T. 13 S., R. 10 W. Photo LC60-1.



LC64 – Base of Greenhorn Limestone at 1,640 ft on both sides of road with good exposure of Greenhorn above; abandoned limestone quarry above at about 1,700 ft but this is lower than Fence-post layer; SE NW SE sec. 8, T. 13 S., R. 10 W. Photos LC64-1, LC64-2, LC64-3.



LC65 – Graneros Shale with Greenhorn Limestone above to top of hill, contact covered; SW NW SW sec. 31, T. 13 S., R. 10 W. Photo LC65-1.



LC66 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,755 ft in road; abandoned Fence-post quarry about 650 ft southeast of LC66 on west side of road; Greenhorn limestone exposed below; SW SW NW sec. 23, T. 13 S., R. 10 W. Photo LC66-1.



LC67 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,775 ft in pasture south of road; thin limestone beds in Carlile above; NW NE NW sec. 22, T. 13 S., R. 10 W. Photo LC67-1.



LC68 – Base of Greenhorn Limestone in roadcut at 1,640 ft; Graneros Shale below in road ditches; NW NW NW sec. 13, T. 13 S., R. 10 W. Photo LC68-1.



KDOT 6 – KDOT K232 plan and profile, base of Greenhorn Limestone at 1,704 ft; NE NW NE sec. 31, T. 13 S., R. 10 W. No photo.

KDOT 7 – KDOT K232 plan and profile, base of Graneros Shale at 1,680 ft; near north line NE NW NE sec. 31, T. 13 S., R. 10 W. No photo.

KDOT 8 – KDOT K232 plan and profile, base of Graneros Shale at 1,630 ft; NE NE SW sec. 8, T. 13 S., R. 10 W. No photo.

KDOT 9 – KDOT K232 plan and profile, base of Greenhorn Limestone at 1,652 ft; SE SE NW sec. 8, T. 13 S., R. 10 W. No photo.

KDOT 10 – KDOT K232 plan and profile, base of Carlile Shale (top of Fence-post limestone bed) at 1,735 ft; NE NE NW sec. 8, T. 13 S., R. 10 W. No photo.

12 WILSON NE QUADRANGLE—LINCOLN COUNTY

Field work conducted 06 Feb 2017; 07 Feb 2017

LC69 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,745 ft in west road ditch; Fence-post ledge with drill holes in ditch; small quarry to west and several abandoned quarries in area; SE NE SE sec. 27, T. 13 S., R. 9 W. Photos LC69-1, LC69-2.



LC70 – Base of Carlile Shale (top of Fence-post limestone bed) at 1,775 ft in east roadcut; good exposure of Carlile above with thin limestone beds and bright red streak of chalky mudrock; SW NW SW sec. 24, T. 13 S., R. 9 W. Photo LC70-1.



13 WESTFALL NW QUADRANGLE—LINCOLN COUNTY

Field work conducted 10 Dec 2015; 11 Dec 2015; 27 Jan 2016; 28 Jan 2016; 17 Feb 2016; 15 Nov 2016

LC13 – Dakota Formation with calcite-cemented sandstone at 1,440 ft in road along south edge of APAC Quartzite Quarry; NE NW NW sec. 26, T. 12 S., R. 8 W. Photo LC13-1.



LC14 – Dakota Formation with calcite-cemented sandstone at 1,435 ft in road along south edge of APAC Quartzite Quarry; NW NE NW sec. 26, T. 12 S., R. 8 W. Photo LC14-1.



LC15 – Dakota Formation with calcite-cemented sandstone at 1,425 ft in pasture about 300 ft south of road that borders the south edge of APAC Quartzite Quarry; NW NW NE sec. 26, T. 12 S., R. 8 W. Photo LC15-1.



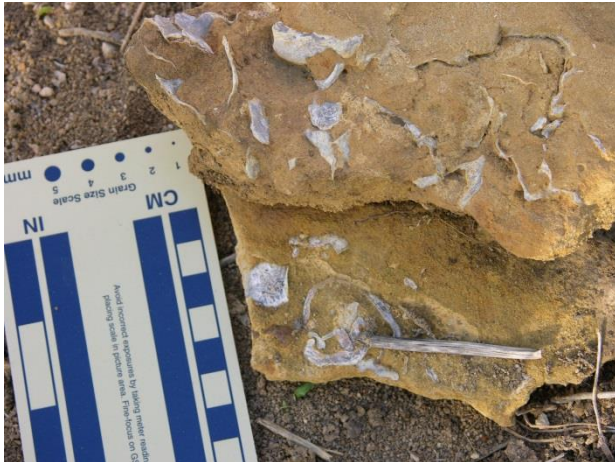
LC16 – Light colored sandstone ledge in Dakota at 1,575 ft in pasture about 700 ft north of road, Dakota mudrock below; NW SE SE sec. 2, T. 13 S., R. 8 W. Photo LC16-1.



LC17 – Base of Greenhorn Limestone at 1,640 ft in roadcut at top of hill; about 5 ft of platy limestone with strong petroliferous odor; contact with Graneros is sharp; near center SW SE sec. 2, T. 13 S., R. 8 W. Photo LC17-1.



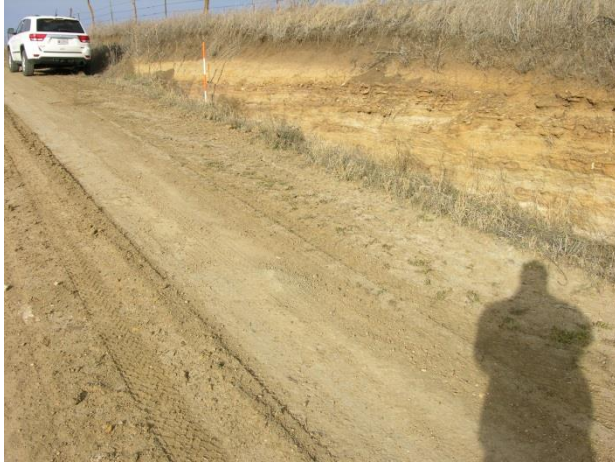
LC18 – Graneros Shale at 1,615 ft in roadcut west of LC17; about 2 ft of calcareous, fossiliferous (bivalves) sandstone below dark gray, fissile shale; this marine sandstone appears to be at or near the base of the Graneros at this location; thickness from sandstone to base of Greenhorn is 24 ft (hand leveled); SW SW SE sec. 2, T. 13 S., R. 8 W. Photos LC18-1, LC18-2, LC18-3.



LC19 – Base of Greenhorn Limestone at 1,655 ft in roadcut; limestone is thin bedded, weathers platy, with strong petroliferous odor, and fossiliferous (*Inoceramus* sp.); contact with Graneros is sharp; SE SE SW sec. 2, T. 13 S., R. 8 W. Photo LC19-1.



LC20 – Base of Graneros Shale at 1,600 ft in roadcut near top of hill; 2 ft of soft, tan sandstone at base of Graneros in sharp contact (erosional) with hard, maroon sandstone in Dakota Formation below; SW SW sec. 2, T. 13 S., R. 8 W. Photos LC20-1, LC20-2, LC20-3.



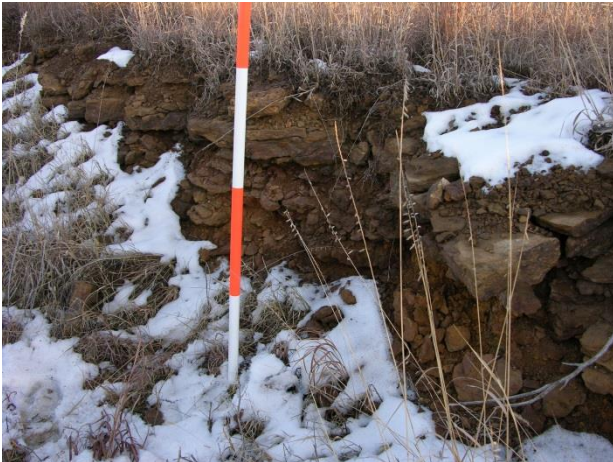
LC21 – Base of Greenhorn Limestone at 1,652 ft on west side of road; poor exposure; limestone is dark gray, crystalline, with strong petroliferous odor; NE NE sec. 30, T. 13 S., R. 8 W. Photo LC21-1.



LC22 – Base of Greenhorn Limestone at 1,640 ft; limestone is dark gray, crystalline, with strong petroliferous odor; SE SE SE sec. 11, T. 13 S., R. 8 W. Photo LC22-1.



LC23 – Base of Graneros Shale at 1,585 ft; SE SE SW sec. 10, T. 13 S., R. 8 W. Photo LC23-1.



LC24 – Base of Greenhorn Limestone at 1,650 ft; limestone is dark gray, crystalline, with strong petroliferous odor; SW SE SW sec. 11, T. 13 S., R. 8 W. Photo LC24-1.



LC25 – Greenhorn Limestone at 1,730 ft, contact concealed; base is probably 50 ft lower; near center sec. 35, T. 13 S., R. 8 W. Photos LC25-1, LC25-2.



LC34 – Base of Greenhorn Limestone at 1,671 ft in dirt road and roadcut; lowermost 2 ft of limestone is dark gray, crystalline, fossiliferous, with strong petroliferous odor; thin-bedded, red sandstone in Graneros Shale 11 ft below base of Greenhorn; near center south line SW SE sec. 29, T. 13 S., R. 8 W. Photo LC34-1.



LC35 – Base of Greenhorn Limestone at 1,685 ft in road and south roadcut; limestone is dark gray, crystalline, with strong petroliferous odor; prominent Greenhorn bench with very distinct brush line about 35 ft above contact to south in brome field; SW SE SE sec. 29, T. 13 S., R. 8 W. Photo LC35-1.



LC36 – Base of Greenhorn Limestone in road and roadcuts at 1,670 ft; thin limestone at base (dark gray, crystalline, with strong petroliferous odor) with chalky shale above; forms bench in pastures in both directions below more prominent bench above as described in LC35; Graneros Shale below is yellow tan; near southeast corner sec. 21, T. 13 S., R. 8 W. Photos LC36-1, LC36-2.



LC58 – Base of Greenhorn Limestone at 1,647 ft in east road ditch; dark gray crystalline limestone, petroliferous odor, with *Inoceramus* sp.; spring below from Graneros Shale; SW NW NW sec. 17, T. 13 S., R. 8 W. Photo LC58-1.



14 WESTFALL QUADRANGLE—LINCOLN COUNTY

Field work conducted 09 Dec 2015; 10 Dec 2015

LC11 – Dakota Formation with four calcite-cemented sandstone concretions at 1,425 ft in pasture about 1,000 ft east of road; near center NW sec. 10, T. 13 S., R. 7 W. Photo LC11-1.



LC12 – Dakota Formation with calcite-cemented sandstone concretions at 1,460 ft in pasture south of paved road; near center NW NW NE sec. 17, T. 13 S., R. 7 W. Photo LC12-1.



15 JUNIATA QUADRANGLE—LINCOLN COUNTY

Field work conducted 09 Dec 2015

LC5 – Dakota Formation with calcite-cemented sandstone at 1,450 ft in hillside on east side of road; NW NW sec. 26, T. 13 S., R. 6 W. Photo LC5-1.



LC6 – Dakota Formation (light gray sandstone) in hillside east of road, no access; NW NW sec. 23, T. 13 S., R. 6 W. No photo.

LC7 – Dakota Formation with calcite-cemented sandstone concretions at 1,350 ft in pasture hillside about 2,000 ft west of road; boulder field, and another to the south, shows up well on NAIP images; no access; SW SE sec. 25, T. 12 S., R. 6 W. Photo LC7-1.



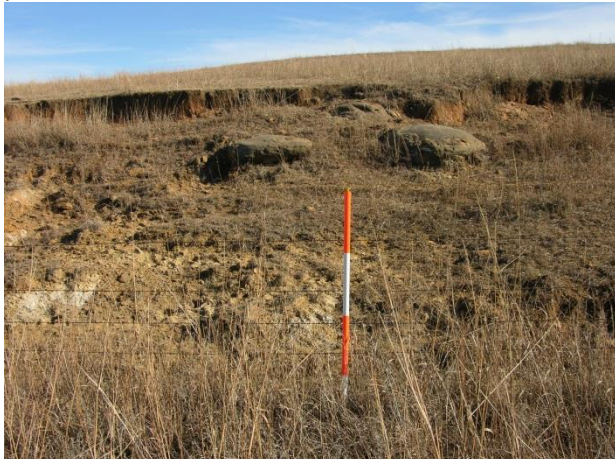
LC8 – Dakota Formation with calcite-cemented sandstone at 1,380 ft in road and pasture to east and in pasture to the northeast; near center of east line SE sec. 25, T. 12 S., R. 6 W. Photo LC8-1.



LC9 – Dakota Formation with calcite-cemented sandstone concretions at 1,340 ft in pasture hilltop about 2,000 ft north of road; no access; NW SE sec. 24, T. 12 S., R. 6 W. Photo LC9-1.



LC10 – Dakota Formation with three small (3 ft) calcite-cemented sandstone concretions at 1,425 ft in pasture on east side of road; SW SW NW sec. 10, T. 13 S., R. 6 W. Photo LC10-1.



16 WILSON QUADRANGLE—LINCOLN COUNTY

Field work conducted 05 Feb 2017

LC61 – Top of Dakota Formation in dirt road (Avenue A) approximately 1.4 mi north of I-70 exit 206; Graneros Shale well exposed above; NE NE NE sec. 6, T. 14 S., R. 10 W. Photo LC61-1. LC61 is located in Ellsworth County.



LC62 – Base of Greenhorn Limestone in dirt road (Avenue A) approximately 1.3 mi north of I-70 exit 206; SE NE NE sec. 6, T. 14 S., R. 10 W. Photo LC62-1. LC62 is located in Ellsworth County.



LC63 – Base of Carlile Shale (top of Fence-post limestone bed) in abandoned quarry in pasture west of dirt road (Avenue A) approximately 1.2 mi north of I-70 exit 206; NE SE NE sec. 6, T. 14 S., R. 10 W. Photo LC63-1. LC63 is located in Ellsworth County.



KDOT 5 – KDOT K232 plan and profile, base of Carlile Shale (top of Fence-post limestone bed) at 1,808 ft; NE SW SE sec. 31, T. 13 S., R. 10 W. No photo.

17 BLACK WOLF QUADRANGLE—LINCOLN COUNTY

No data control points.

18 WESTFALL SW QUADRANGLE—LINCOLN COUNTY

No data control points.

19 WESTFALL SE QUADRANGLE—LINCOLN COUNTY

Field work conducted 27 Jan 2016

KDOT 1 – KDOT I-70 plan and profile, base of Greenhorn Limestone at 1,705 ft; NW NE NE sec. 2, T. 14 S., R. 7 W. (located in Ellsworth County). No photo.

KDOT 2 – KDOT I-70 plan and profile, base of Greenhorn Limestone at 1,700 ft; NW SE SE sec. 36, T. 13 S., R. 7 W. KDOT thicknesses: Greenhorn Limestone = 79 ft (Lincoln = 20 ft, Hartford = 17 ft, Jetmore = 21 ft, and Pfeifer = 21 ft. No photo.

KDOT 3 – KDOT I-70 plan and profile, base of Graneros Shale at 1,656 ft; NE SE SE sec. 36, T. 13 S., R. 7 W. KDOT thickness: Graneros Shale = 46 ft. No photo.

20 BROOKVILLE SW QUADRANGLE—LINCOLN COUNTY

Field work conducted 08 Dec 2015

LC1 – Kiowa Formation in stream bank southeast of bridge over Mulberry Creek; dark gray fissile shale above slabby sandstone interbedded with dark gray shale; fine-medium grained, yellow-tan sandstone above stream bank exposure in road ditch to south; NW NW NW sec. 6, T. 14 S., R. 5 W. (located in Saline County). Photo LC1-1. Compare to LC4.



LC2 – Calcite-cemented sandstone in road and pasture north of road at 1,450 ft. Bayne et al. (1971) mapped this area as Kiowa Formation; NW NW NW sec. 1, T. 14 S., R. 6 W. Photo LC2-1.



LC3 – Kiowa Formation/Dakota Formation contact at 1,440 ft in rechanneled Table Rock Creek on south side of road; very light gray mudrock above 4 in. of very light gray sandstone (Dakota) in contact with approximately 2 ft of dark gray, sandy mudrock below (Kiowa); creek bed littered with marcasite nodules, probably from Kiowa; NW NW NE sec. 3, T. 14 S., R. 5 W. (located in Ellsworth County). Photos LC3-1, LC3-2, LC3-3, LC3-4.



LC4 – Kiowa Formation in high stream bank in pasture about 500 ft west of LC1; dark gray shale below yellow-tan sandstone that appears to be a channel fill cut into the shale; dark gray shale is Kiowa and the sandstone is probably Kiowa too, but it could be Dakota; NE NE NE sec. 1, T. 14 S., R. 6 W. (located in Ellsworth County). Photos LC4-1, LC4-2, LC4-3.

